FLAT PARTICLES, ELONGATED PARTICLES, OR FLAT AND ELONGATED PARTICLES IN COARSE AGGREGATE

ASTM D 4791
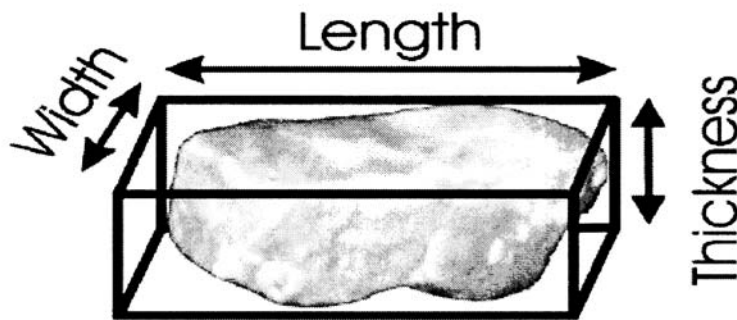
GLOSSARY

Flat and Elongated Particles of Aggregate - Those particles having a ratio of length to thickness greater than a specified value.

Length - the maximum dimension.

Thickness - the maximum dimension perpendicular to the length and width.

Width - the maximum dimension in the plane perpendicular to the length.

SCOPE

This test method covers tests for flat particles, elongated particles, or flat and elongated particles in coarse aggregate. In this text only flat and elongated particles will be covered because at this time the only national specification that references this test is the Superpave Specification, which refers to Flat and Elongated Particles in Coarse Aggregate.

Flat and elongated particles of coarse aggregates have a tendency to fracture more easily than other aggregate particles. When the coarse aggregate does fracture, the gradation will likely change which may be detrimental to the mix. Additionally, flat and elongated particles of aggregate, for some construction uses, may interfere with consolidation and may result in harsh, difficult to place mixtures.

SUMMARY OF TEST

Individual aggregates of specific sieve sizes are tested for ratios of width to thickness, length to width, or length to thickness. The test is performed on a sample of coarse aggregate reduced from a representative field sample. The sample is sieved to separate each size larger than the 3/8 in. (9.5 mm) sieve. Each size is then tested in a proportional caliper device. Particles are weighed to determine a percentage of flat, elongated, or flat and elongated particles in a sample. Superpave specifications require hot mix asphalt to have less than 10% flat and elongated particles using a 5:1 ratio.

Apparatus

Proportional Caliper Device.

Balance, accurate to 0.5% of the weight of the sample.

Oven or hot plate (if determination is made by weight)

Sample Size

Set up the test sample according to the following table:

Nominal Maximum Size	Minimum Weight
3/8 in. (9.5 mm)	2 lbm. (1 kg)
1/2 in. (12.5 mm)	4 lbm. (2 kg)
3/4 in. (19.0 mm)	11 lbm. (5 kg)
1 in. (20.5 mm)	22 lbm. (10 kg)
1 1/2 in. (37.5 mm)	33 lbm. (15 kg)
Note: This is the entire sample. Only test the sieve sizes that are present in the amount of 10% or more of the original sample.	

Procedure

1.   If determination by weight is required, oven dry the sample to a constant weight at a temperature of 230° ± 9°F (110° ± 5°C). If determination is by particle count, drying is not necessary.

2.   Sieve the sample of coarse aggregate to be tested in accordance with test method AASHTO T 27. Reduce each size fraction larger than the 3/8 in. (9.5 mm) sieve that is present in the amount of 10% or more of the original sample in accordance with method AASHTO T 248 until approximately 100 particles are obtained.

3.   Use the proportional caliper device positioned at the 5:1 ratio.

4.   Set the larger opening equal to the particles longest dimension. The particle is considered flat and elongated if the particles thinnest dimension passes through the smaller opening. (Figures 1 and 2)
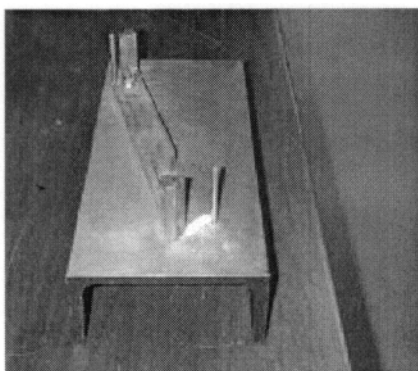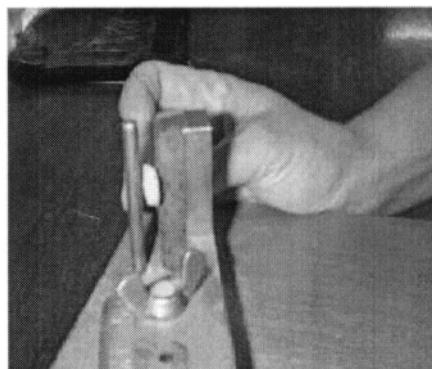

Figure 1
Checking Elongation

Figure 2
Checking Flatness

On calipers similar to the one shown in Figure 3, set the minimum dimension of the device such that the particle, when oriented to measure its thickness, passes snugly between the post and swing arm. The particle is considered flat and elongated if the particle fails to pass the desired large opening of the device.
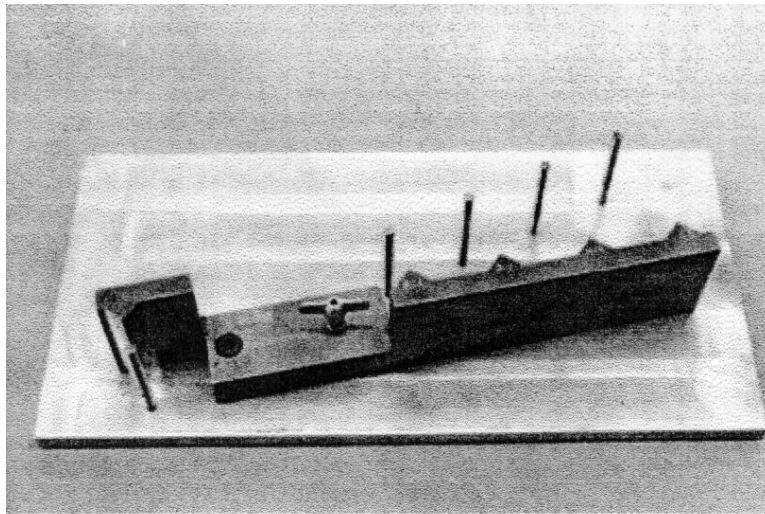
Figure 3

5.   Test each of the particles in each size fraction and place them into one of two groups: (1) Particles with longest to thinnest ratios over 5:1 and (2) Particles with longest to thinnest ratios less than 5:1

6.   After the particles have been classified into the two groups, determine the proportion of the sample in each group by either count or by weight as required.

Calculation

Calculate the percentage of flat and elongated particles to the nearest 1% for each sieve size greater than 3/8 in. (9.5 mm).

Example

3/4 in. (19.0 mm) Stone

Sieve	1 in. (25.0 mm)	3/4 in. (19.0 mm)	1/2 in. (12.5 mm)	3/8 in. (9.5 mm)
% Passing	100	99.4	75.7	46.4
% Retained	0	0.6	23.7	29.3

No test is performed on the 3/4 in. (19.0 mm) size aggregate because it is less than 10 percent of the total sample. It will be assumed that the 3/4 in. (19.0 mm) particles have the same percentage of flat and elongated as the next sieve 1/2 in. (12.5 mm).

The 1/2 in. (12.5 mm) size material totaled 715.3 grams after reducing to approximately 100 particles. 6.9 grams were classified as flat and elongated, therefore, the percent flat and elongated on the 1/2 in. (12.5 mm sieve) is:

$$\frac{6.9}{715.3} \times 100 = 1.0\% \approx 1\%$$

Likewise, the 3/8 in (9.5 mm) size totaled 239.7 grams after reduction and 12.2 grams were classified as flat and elongated. The percent flat and elongated on the 3/8 (9.5 mm) sieve is:

$$\frac{12.2}{239.7} \text{ x } 100 = 5.1\% \approx 5\%$$

The percentage of flat and elongated particles on each sieve is reported to the nearest whole percent.